TEMPERATURE ADJUSTING DEVICE FOR AN LED LIGHT SOURCE

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to a temperature adjusting device for an LED light source that is provided with an LED light source, a temperature sensor for detecting an ambient temperature of the LED light source, a cooling fan for cooling the LED light source, a driving circuit for driving the cooling fan, and a control unit which on/off controls a voltage to be applied to the cooling fan so as to set the ambient temperature within a predetermined range based upon the results of detection by the temperature sensor.

2. Description of the Related Art

With respect to a light source used in a copying machine, an image-reading apparatus and the like, after turning the light source on, a temperature rise tends to occur due to self heat generation to cause changes in the light source characteristics and the resulting adverse effects in image quality of a read image. For this reason, a device which carries out temperature adjustments so as to adjust the ambient temperature (environmental temperature) of the light source within a predetermined temperature range by using a heater and a cooling fan has been proposed. For example, JP-A No. 2-267541 has been known as such a device using a fluorescent

lamp as the light source.

Further, in a photographic processing device for forming photographic prints, a scanner for reading frame images formed in a developed negative film has been used. With respect to a reading light source for use in this scanner, a halogen lamp has been generally used. Here, those light sources using an LED light source have also been known from the viewpoints of its long life and elimination of the need for exchanging the light sources. For example, JP-A No. 2002-365735 has disclosed such a photographic film reading device.

In the case when an LED light-source is used, the LED is subjected to changes in characteristics in the light amount and wavelength depending on temperatures and the subsequent changes in the reading performance; therefore, it is necessary to carry out temperature adjustments. In order to carry out the temperature adjustments, a temperature sensor for detecting the environmental temperature at which the LED light source is placed is installed, and when the preset temperature range is exceeded, a cooling fan is turned on so as to lower the temperature. When the temperature is cooled to a preset temperature, the cooling fan is turned off.

However, the control method for on/off controlling the above-mentioned cooling fan has the following problems. Since, up n turning the c ling fan n, the LED is quickly c l d, th charact ristics of the LED tend t deviate. LED light s urc s of

three colors are required in order to read an image of a color photographic film; however, when there are deviations in the characteristics, adverse effects are caused on the reading performances. Moreover, when the cooling fan is quickly turned on and off, changes in noise are offensive to the ear, and make the workers uncomfortable.

When a halogen lamp is used as the light source, a cooling fan is also used; however, since the halogen lamp is less susceptible to changes in characteristics due to the ambient temperature, the cooling fan can be continuously rotated without the necessity of turning on and off. When the cooling fan is continuously rotated, the noise from the fan is not offensive to the ear. In the case of the LED light source, however, since the characteristics thereof are changed depending on the ambient temperature, it is not possible to keep the cooling fan rotating all the time.

The present invention has been devised so as to solve the above-mentioned problems, and its objective is to provide a temperature adjusting device for an LED light source which, upon temperature-adjusting the LED light source by using a cooling fan, neither causes unnecessary deviations in characteristics in the LED, nor makes the workers uncomfortable due to abrupt changes in noise.

SUMMARY OF THE INVENTION

In order to achieve the above-mentioned objective, a temperature adjusting device for an LED light source in accordance

with th pr sent inv nti n is provided with an LED light s urc , a temperature sensor for detecting an ambient temperature of the LED light source, a cooling fan for cooling the LED light source, a driving circuit for driving the cooling fan, and a control unit which on/off controls a voltage to be applied to the cooling fan so as to set the ambient temperature within a predetermined range based upon the results of detection by the temperature sensor, and in this arrangement, upon on/off controlling the applied voltage, the control unit is allowed to gradually raise/lower the applied voltage.

In this arrangement, the control unit which on/off controls the voltage to be applied to the cooling fan is installed. Moreover, upon turning the voltage to be applied on from the off-state, the voltage is not applied abruptly as a target voltage, but applied as a gradually increasing voltage toward the target voltage. With this arrangement, the number of revolutions of the cooling fan is gradually increased so that the LED is not cooled abruptly. Moreover, noise, generated by the cooling fan, gradually increases so that it is possible to avoid making the workers uncomfortable. In the same manner, upon turning the voltage to be applied off from the on-state, the applied voltage is gradually lowered. As a result, it is possible to provide a temperature adjusting device for an LED light source which neither causes unnecessary deviations in characteristics in the LED, nor makes the workers unc mfortabl due to abrupt changes in nois .

With resp ct t a preferred emb dim nt f the pres nt

inv ntion, th ab ve-menti n d LED light source is preferably us d as a scanner-use light source used for reading frame images of a photographic film.

In particular, in the case when a color photographic film is read, LED light sources of three colors are required; therefore, when there are deviations in characteristics of the respective LEDs, adverse effects might be given to image quality of a read image. In other words, in the case when an LED light-source is used as a scanner-use light source used for reading a photographic film, the arrangement of the present invention particularly exerts superior effects.

In another preferred embodiment of the present invention, the above-mentioned LED light source is formed into a line shape along the width direction of a photographic film that is to be read, and a line-shaped heater to be placed in parallel with the line direction of the LED light source is prepared, and in this arrangement, the control unit turns the above-mentioned heater off in synchronism with the turning-on of the LED light source, while it on/off controls the above-mentioned cooling fan irrespective of the turning on/off of the heater.

In order to appropriately carry out temperature adjustments of the LED light source, the temperature control is preferably carried out to an environmental temperature slightly higher than the temp rature f a r om in which the scann r is plac d. In other w rds, in the cas wh n the envir nm ntal t mperature is set t a

temperature low r than the r om temperatur , since the temperature is always influenced by the room temperature, the blower fan needs to be continuously set to the on-state. Here, in such a cooling method, the environmental temperature inside the LED unit is susceptible to irregularities. As a result, it is not possible to stabilize the light emission of the LED so that this method is not suitable for the formation of a photographic image that needs to be dealt as high image-quality data. With respect to the supply ends of the photographic processing devices, there are warm areas and cold areas, and when all those supply ends are taken into consideration, the environmental temperature of the LED needs to be set to, for example, a temperature slightly higher than the temperature (or recommended environmental temperature of the machine) of a warm area.

In this case, when the reading operation for a photographic film is started, it is preferable to preliminarily set the temperature to a desired environmental temperature. Therefore, the line-shaped heater is placed adjacent to the line-shaped LED light source, and prior to the application of the LED light source, the heater is used to heat the LED light source to be set to the desired environmental temperature. When the LED light source is actually turned on, the heater is turned off. After turning the LED light source on, since the LED itself generates heat, it is not necessary t turn the heat r on. In oth r w rds, when th LED light sourc is off, h at is g n rated by the heater, and wh n the LED light

s urce is n, heat is g nerat d by the LED light sourc itself. Therefore, irrespective of the turning on/off of the heater, the setting of the environmental temperature is carried out with high precision by on/off controlling the cooling fan.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view that shows a structure of a scanner device in which an LED light source is used.

FIG. 2 is a block diagram that explains a temperature adjusting device of the LED light source and functions thereof.

FIG. 3 is a graph that explains the contents of the temperature adjusting process.

FIG. 4 is a time chart in the case when the scanner is used.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to Figures, the following description will discuss preferred embodiments of a temperature adjusting device for an LED light source in accordance with the present invention. Fig. 1 is a perspective view that shows a structure of a scanner device in which an LED light source is used. Fig. 2 is a block diagram that explains a temperature adjusting device of the LED light source and functions thereof.

<Structure f Scanner Device>

This scanner devic 1 is used for reading frame images formed

n a ph tographic film F, such as a negativ -working film and a positive-working film, to form electronic data. With a transporting face on which a photographic film F is transported being sandwiched in between, LED light sources 11r, 11g and 11b serving as reading light sources are placed on one side, and a CCD line sensor 2 serving as a reading sensor is placed on the other side. The red LED light source 11r, the green LED light source 11g and the blue LED light source 11b are installed in order to acquire color image data from the color photographic film. The respective LED light sources are formed in a line shape in association with the line-shaped CCD line sensor 2.

In comparison with a case in which a halogen lamp is used as the light source, the LED light source has a longer service life, and also has the advantage that hardly any exchanging operations are required. Moreover, the halogen lamp requires a light-adjusting filter, while the LED light source requires no light-adjusting filter. This is because, for example, in order to deal with differences in color in the base of the negative working film, it is only necessary to adjust the output of each of the LED light sources. Therefore, it is possible to simplify the structure of the scanner device.

An optical fiber 13 for guiding light rays applied from the respective LED light sources 11r, 11g and 11b is installed. The optical fiber 13 includes a red LED-use guide portion 13r, a green LED-us guid porti n 13g and a blue LED-use guid porti n 13b, and these p rti ns are joined into a joining p rti n 13a, and

utputt d to the phot graphic film F in a mix d color state. The light rays, applied from the optical fiber 13, are allowed to pass through the photographic film F, and made incident on the CCD line sensor 2 through a converging lens 3. By transporting the photographic film F at a constant speed, image data corresponding to the frame images formed on the photographic film are successively acquired.

As shown in Fig. 2, the respective LED light sources 11r, 11g and 11b are attached to LED substrates 10r, 10g and 10b. Moreover, heaters 12r, 12g and 12b are placed adjacent to (in parallel with) the line-shaped LED light sources 11r, 11g and 11b. These heaters 12r, 12g and 12b are required so as to control the ambient temperature at which the LED light-sources 11r, 11g and 11b are placed to a predetermined range. As the ambient temperature changes, the LED light sources 11r, 11g and 11b also change in characteristics thereof, such as light quantity and wavelength. Consequently, the quality of read images deteriorates. Therefore, in the case when the LED light sources 11r, 11g and 11b are used as scanner-use light sources, it is necessary to carry out temperature adjustments.

A control unit 4 (MPU) that controls the temperature-adjusting device is installed. The control unit 4 carries out controlling operations on respective units in accordance with set programs. Light-quantity data, r quired for driving th LED light-sour s 11r, 11g and 11b, are sent t a D/A c nversi n unit 7 from th c ntrol

unit 4 so that th respective LED light s urces 11r, 11g and 11b are driven through an LED driving circuit 6. The LED light sources 11r, 11g and 11b are driven and controlled by current-controlling operations.

Moreover, data, required for driving the heaters 12r, 12g and 12b, are sent to a D/A conversion unit 5 so that the respective heaters 12r, 12g and 12b are driven through a heater driving circuit 8. The respective LED light sources 11r, 11g and 11b and the respective heaters 12r, 12g and 12b are installed on substrates 10r, 10g and 10b.

Furthermore, a cooling fan 20 for adjusting the ambient temperature is installed. The ambient temperature is always monitored by a temperature sensor 9, and when the ambient temperature is out of a predetermined range, the cooling fan 20 is on/off controlled. The cooling fan 20 is turned on (activated) by applying a predetermined voltage thereto. Voltage data are sent to a D/A conversion unit 21 from the control unit 4 so that the cooling fan 20 is driven and controlled based upon a voltage applied thereto from a fan driving circuit 22. A signal from the temperature sensor 9 for measuring the ambient temperature is amplified in an amplifier 23. This signal is converted by an A/D conversion unit 24, and sent to the control unit 4. Based upon these temperature data, the control unit 4 on/off controls the ling fan 20.

<Temperature Adjustments>

The following description will discuss a specific meth d for adjusting the temperature by the use of a temperature adjusting device as shown in Fig. 2. Fig. 3 shows a graph that explains the contents of the temperature adjustments, and the axis of abscissas indicates the elapsed time and the axis of ordinates indicates the ambient temperature detected by the temperature sensor 9. T_D represents a set temperature. T_3 represents a lower limit temperature of a permissible range. T_4 represents an upper limit temperature in the permissible range. Here, T_1 represents a temperature at which the cooling fan 20 is switched off. T_2 represents a temperature at which the cooling fan 20 is switched on.

Fig. 3(b) shows a graph that explains a conventional on/off controlling method. When the ambient temperature exceeds the upper-side switching temperature T_2, a voltage V is abruptly applied to allow the cooling fan 20 to start rotating abruptly. After the cooling fan 20 has been driven, the ambient temperature is gradually lowered, and when the ambient temperature goes lower than the lower-side switching temperature T_1, the cooling fan 20 is switched off so that the applied voltage suddenly drops from V to 0. Consequently, the operation of the cooling fan 20 is suddenly stopped. However, such abrupt on/off operations for the applied voltage cause abrupt changes in noise, making the workers uncomfortable due to offen iv n is to th ear. More ver, when th LEDs are abruptly c oled, gr ater adverse effects du t

changes in the characteri tics are caus d.

For this reason, controlling operations as shown in Fig. 3(c) are carried out. In other words, when the ambient temperature exceeds T_2, the applied voltage to the LED light sources 11r, 11g and 11b is gradually increased. The time period is represented by Δt. The time period is preferably set to 1 to 2 seconds. This is because the time period of less than 1 second fails to eliminate offensive noise, while the time period exceeding 2 seconds causes degradation in temperature-controlling precision. Moreover, in the case when the ambient temperature goes below T_1, the applied voltage is gradually lowered in the time period of Δt. Thus, the changes in noise are smoothed so that offensive noise to the ear is eliminated. Moreover, since the LED light source is not cooled abruptly, it is possible to reduce changes in the characteristics of the LED.

<Time Chart>

Next, referring to Fig. 4, the following description will discuss a time chart that is used when frame images in a photographic film are read by using the scanner 1. In Fig. 4, a photographic film is set in the scanner 1 so that timing t_1 in which the film is transported is indicated. The completion of the transporting process is indicated by t_2. The LED light source is turned on at t_0 prior to the start of the transporting process of the photographic film, and is turned off at t_3 after th c mpl ti n f th transporting proc ss. Mor over, the heater is turned ff in synchronism with

the turning-on of the LED light sourc (alth ugh not shown in Fig. 4, the on/off control of the heater has been started upon carrying out a warming-up process of the photographic processing apparatus). The ambient temperature in which the LED is used needs to be always set in a predetermined range (T_3 to T_4). This temperature range is set to, for example, not less than 40° C. This temperature is slightly higher than the ambient temperature at which the scanner device is installed. Therefore, in order to maintain the ambient temperature of the LED light source at a predetermined level, even when the scanning process of the photographic film is not carried out, the heater is maintained in the on-state during the corresponding time. Since, during the on-state of the LED light source, the LED itself generates heat, it is not necessary to turn the heater on, and the heater is maintained in the off-state.

For the reason, as described above, the cooling fan 20 is also controlled so as to be always operable. In other words, as shown in Fig. 4, irrespective of the on/off operation of the heater, operation controls are carried out on the cooling fan. Thus, the ambient temperature at which the LED light sources are placed is always maintained appropriately.

<Another Embodiment>

(1) The temperature adjusting device in accordance with the pres nt invention is applicable not only t th ca in which an LED light source is used for a scanner d vic , but also to the cas

in which it is used for an exposing light source which exposes and prints an image onto a photosensitive material.

(2) The structure of a light path that directs light from the LED light source to a photographic film is not limited by the present embodiment, and various modified embodiments may be proposed. For example, the light path structure may be formed by using not an optical fiber, but a dichroic mirror and a prism.

(3) In the present embodiment, when the applied voltage is gradually raised or lowered, the voltage is linearly increased or reduced; however, the present invention is not intended to be limited by this method. For example, the voltage may be increased or reduced in a curved manner. Moreover, the voltage may be increased or reduced by changing the voltage step by step. The voltage may be changed in a combined manner between a straight line and a curved line. In short, the voltage may be gradually changed within a range in which the functions and effects of the present invention are properly exerted.

(4) The present embodiment has exemplified a case in which three LEDs are used; however, in the case when a white-color LED is used, the structure may include a single LED.